RESEARCH

3(9), March 1, 2013

ISSN 2278–5469 EISSN 2278–5450

Discovery

Comparative performance of Cassava Starch to PAC as Fluid Loss Control Agent in Water Based Drilling Mud

Egun IL[1☼], Achadu M Abah[2]

1.Research scholar, Dept. of Chemical Engineering, University of Port Harcourt, P.M.B. 5323, PHC, R/S, Nigeria
2.Lecturer, Dept. of Chemical Engineering, Univ. of Port Harcourt, P.M.B. 5323, PHC, R/S, Nigeria

☼Corresponding author: Research scholar, Univ. of Port Harcourt, P.M.B. 5323, PHC, R/S, Nigeria, E-Mail: isiegun@yahoo.com

Publication History
Received: 07 January 2013
Accepted: 16 February 2013
Published: 1 March 2013

Citation
Egun IL, Achadu M Abah. Comparative performance of Cassava Starch to PAC as Fluid Loss Control Agent in Water Based Drilling Mud. *Discovery*, 2013, 3(9), 36-39

ABSTRACT

Cassava starch was extracted from 46.5kg of TMS 98/0505 species of fresh cassava tubers and characterized to establish the physicochemical properties The analytical results showed the following; moisture content (4.11%), pH (7), dispersion (poly dispersed), bulk density (617.34kg/m^{33}) and particle size distribution (fine). It was also compared to the standard Polyanionic Cellulose (PAC) used in the oil and Gas industry for water based mud (WBM) formulation. The result also indicated closer similarity between TMS 98/0505 and PAC. It was therefore employed in the production of drilling mud. Different ratios (100:0 and 100:0) of cassava starch and PAC and used to formulate standard drilling mud. The fluid loss properties of the different drilling mud samples were tested. The filtrate volume (fluid loss) obtained for various samples using a concentration of 2g/bbl of starch/PAC were 9.2 ml and 4.2ml, while that obtained at 4g/bbl ,6g/bbl, 8g/bbl of Cassava starch (100:0) were 8.0ml,7.2ml and 6.0 ml. The result also showed that the amount of cassava starch used is indirectly proportional to the filtrate volume. Conclusively, cassava starch could be used as a fluid loss additive and improved to yield a better performance in terms of its water retention capability.

Keywords: cassava starch, Water Based Mud (WBM), Fluid loss and PAC

Abbreviation: PAC – Polyanionic Cellulose

1. INTRODUCTION

1.1. Drilling Fluid (mud)

Drilling fluid also known as drilling mud is a vital component of any drilling operation. In the early days, the primary function of drilling mud was to bring the drill cutting from the bottom of the hole to the surface. Today, it is recognized that drilling mud has many more important functions (Engelhardt et al, 1983; Barlow and Kingston, 2001).

1.2. Types of Drilling Fluid

Drilling mud contains a base fluid and a mixture of chemical additives manufactured to perform a variety of functions during drilling (Davies and

Kingston, 1992). The mud can be classified into different categories according to their base fluid (Caenn and Chillingar, 1996).

1.3. Composition of Drilling Fluid

Drilling mud often contain a variety of chemicals which are formulated as required from a general limited list of additives (Holdway, 2002). These include: Weighting agents, Viscosifiers, Surfactants, Thinners, Fluid loss control agents, Shale stabilization agent and pH adjusters (Terzaghi et al, 1988).

1.4. Fluid loss control Agent

Fluid loss control agents are additives that are added to drilling mud formulation to reduce the loss of fluid from the mud into the drilled formation. This fluid loss control help to maintain hole integrity, protect water sensitive shale, minimize hole washout to achieve better casing cement jobs, reduce fluid loss to productive formation , minimize formation damage and to reduce log analysis problems (Carlos and George, 2004). Caenn and Chillingar (1996), has shown that over the years drilling mud formulators have been using synthesized modified starch such as Polyanionic Cellulose, Carboxyl methyl Cellulose and other polymers as fluid loss control additive.

1.5. Cassava (TMS 98/0505)

This is recent hybrid specie of the Tropical Manihot Spp. This specie is of the tropical climate that has a high starch yield of about 67.1%. It has a wide ecological adaptation and it has a high resistant for pest and disease. It is composed of 36.2% dry matter and has a garri yield of 22.5% and root yield of 45.8 t/ha (NRCRI, 2010).

1.6. Cassava Starch

Cassava starch is one of the most abundant substances in nature; a renewable and also unlimited resource. Cassava starch is gotten from the root or tubers of cassava plant. Starch is the main constituent of cassava; about 25% starch may be obtained from mature, good quality tubers (IITA, 2005). Cassava starch is produced primarily by the wet milling of fresh cassava roots or by also leaching and drying the root of the cassava plant (IITA, 2005).

Table 1 Formulation for One Barrel of Mud

Additive	Concentration	Function
Water	316.4	Base Fluid
Caustic Soda	0.2g	Alkalinity Control
Soda Ash	0.2g	Calcium ion Removal
Polyanionic Cellulose (PAC)	2.0g	Filtration Control
Xanthum Gum	2.8g	Viscosifier
Potassium Chloride	18g	Inhibition Control
Barite	76.8g	Weighting Agent

Source: Hamilton (2001)

Table 2 Physiochemical properties of Cassava Starch

Parameter	TMS 98/0505	PAC (Reference)
pH @ 25°C	7	7
Moisture Content	4.11%	< 7%
Bulk Density (kg/m^3)	617.3	641-881
Particle size Distribution	Fine	Fine
Dispersion	Poly dispersed	Poly dispersed
Appearance	Whitish`	Whitish

2. SCOPE OF THE STUDY

The aim of this research work includes extraction and characterization of starch from hybrid cassava species, production of water based drilling mud using cassava starch in place of Polyanionic Cellulose as a fluid loss additive as well as determination of the produced drilling mud fluid loss property.

2.1. Materials

The equipment used for this study includes: Fresh Cassava Tubers, Mastersizer, Oven (Type 48 BE Apex Tray Drier), Local Mechanical Grater, Weigh Balance, Measuring Cylinder, Beakers, Hamilton Beach Mixer and Cup, pH indicator Strip, Thermometer, Knife, Sieving Mesh, Bucket, Bowl and Stop Watch.

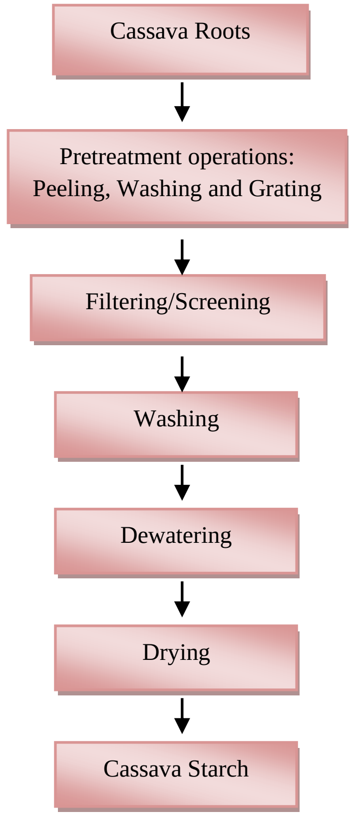

Figure 1
Flow diagram of Cassava Extraction Process

2.1.1. Reagents/ Chemicals

The chemicals and reagents used for this work are listed as follows: Water (H_2O), Caustic Soda ($NaOH$), Soda ash (Na_2CO_3), Polyanionic Cellulose (PAC), Cassava Starch, Potassium Chloride (KCL), Barite, Xanthum Gum.

2.2. Methodology

Cassava (Tropical Manihot Specie 98/0505) aged 11 months was freshly harvested from the Agricultural Development Programme (ADP) Farm, Rumuodomaya Port Harcourt .Nigeria. Physical treatment operations - washing, peeling and grating were carried out on the cassava prior to starch extraction.

2.2.1. Extraction, Purification and Concentration of Cassava Starch

The cassava starch was extracted using traditional method (Fig.1). The pulp mash grated by mechanical grater was mixed with three (3) litres of water for easy filtration. The pulp was placed unto a muslin/ nylon screen which was tied on a bucket and the mash was sifted through the muslin screen batch wise while water was added continuously to aid the screening. The pulp was further rinsed with water to extract as much starch as possible. The filtrate was allowed to settle under gravity for about 3 hours. The starch extract (filtrate) was mixed with water again to remove traces of impurities and contaminants. The mixture was subjected to filtration operations the second time and then concentrated using sack made of cloth. The starch obtained were dried in an electric thermo- regulated oven at a temperature of 60°C steadily for 3 hours to form cake and then sieved to reduce particle size to fine texture. The sieved powdered starch obtained were packaged and sealed at room temperature (25°C) for further analysis.

2.2.2. Estimation of Physicochemical Property of Cassava Starch

The physicochemical properties of the cassava starch were measured as presented:

2.2.2.1. Particle Size Distribution

2.00 g of the starch sample was weighed and poured into pastry dishes. Distilled water in a beaker was employed to calibrate the mastersizer; the value of obscuration was noted. The starch specie was feed into the beaker that contained distilled water of the Malvern instrument mastersizer for the analysis. The result was automatically displayed on the printable screen and recorded.

2.2.2.2. Bulk Density

50.0g of the starch sample was weighed and poured into separate measuring cylinders containing water. Change in volumes were observed and recorded. The density of the starch samples were measured using Equation 1.

$$Density = \frac{Mass\ of\ Starch\ Sample}{Volume\ occupied\ Mass\ of\ Starch\ Samples} \tag{1}$$

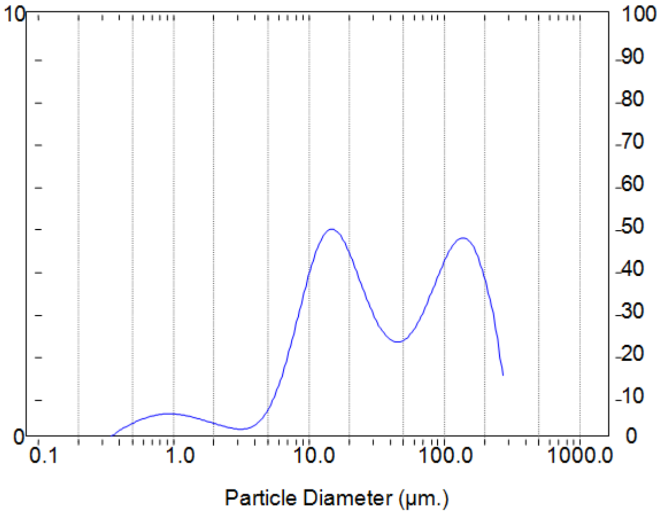

Figure 2
Graph of Particle Diameter Vs Volume (TMS 98/0505)
(Source: mastersizer displayed result)

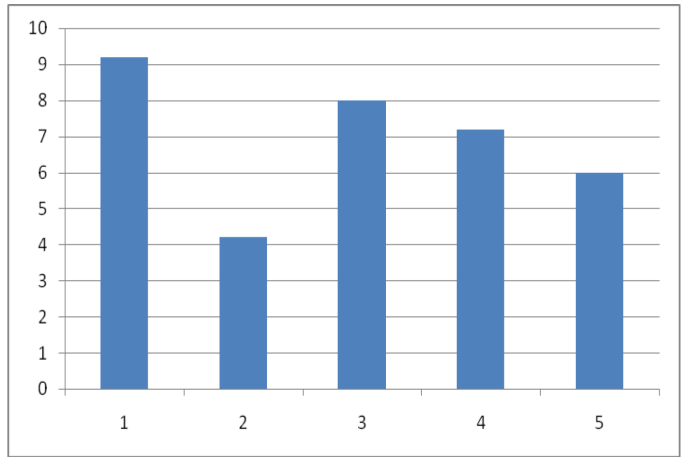

Figure 3
Bar Chart of Filtrate Volume to Mud Samples

2.2.2.3. pH Values

20.0g of cassava starch sample was weighed separately and 200ml of distilled was mixed with sample in a Hamilton Beach mixer cup with the aid of a magnetic stirrer to obtain homogenous mixture (complete dissolution). The pH of starch solutions were determined by dipping the indicator probe into the solution. Three repetitions were made for each of the samples and the mean value recorded.

Table 3 Particle size distribution for TMS 98/0505

ID: tms 0505	Run No: 1	Measured: 22/6/2011 11:49AM
File: 900AULT	Rec. No: 2	Analysed: 22/6/2011 11:49AM
Path: C:\SIZERMU\DATA\		Source: Analysed
Sampler: Internal		Measured Beam Obscuration: 10.4 %
Presentation: 4OHD	Analysis: Polydisperse	Residual: 0.909 %
Modifications: None		
Conc. = 0.0174 %Vol	Density = 1.000 g/cm^3	S.S.A. = 0.7501 m^2/g
Distribution Volume	D[4, 3] = 65.65 um	D[3, 2] = 8.00 um
D(v, 0.1) = 6.05 um	D(v, 0.5) = 30.19 um	D(v, 0.9) = 175.92 um
Span = 5.627E+00	Uniformity = 1.747E+00	

Mesh No	Aperture um	Volume In%	Volume Below%	Mesh No	Aperture um	Volume In%	Volume Below%
10	2000	0.00	100.00	60	250	3.21	98.07
12	1700	0.00	100.00	70	212	4.21	94.86
14	1400	0.00	100.00	80	180	5.47	90.65
16	1180	0.00	100.00	100	150	5.74	85.18
18	1000	0.00	100.00	120	125	4.99	79.44
20	850	0.00	100.00	140	106	4.49	74.45
25	710	0.00	100.00	170	90	4.30	69.96
30	600	0.00	100.00	200	75	3.45	65.66
35	500	0.00	100.00	230	63	2.94	62.21
40	425	0.00	100.00	270	53	2.56	59.27
45	355	0.04	100.00	325	45	2.65	56.71
50	300	1.88	99.96	400	38		54.06
60	250		98.07				

(*Source*: mastersizer displayed result)

2.2.2.4. Moisture Content

20.0g of starch sample was weighed separately into a previously weighed pastry dishes. The starch sample in the pastry dishes were placed in temperature controlled oven, previously stabilized at 120°C for 60 minutes. The samples were reweighed and replaced in the oven. The process was repeated at 60, 30 and 15 minutes until constant weights were achieved. The moisture contents of the starch samples were obtained using Equation 2 below.

$$Percentage\ Moisture\ Content = \frac{Mi - Mf}{Mi}\ X\ 100 \qquad (2)$$

Where:
M_i = Initial mass of starch sample (before drying)
M_f = Final mass of starch sample (after drying).

2.2.3. Production of Water Based Drilling Fluid

2.2.3.1. Formulation Technique

The industry standard measurement for producing water based drilling fluid sample is based on pounds per barrel (lb/bbl). This is the expected density of the drilling fluid which determines the proportions of the other additives. The additives, concentrations and their functions in a drilling fluid as used for this paper are shown in Table 1.

2.2.3.2. Production of Drilling Mud Samples

The appropriate quantities of additives (Table 1) were added to the base fluid while stirring continuously with a Hamilton beach mixer. The additives were added in the order listed in Table 1 with a control mixing time of 2 minutes for each additive. The productions were accomplished with different ratios (100:0 and 100:0) of 2g/bbl concentration of cassava starch replacing PAC. The production was repeated with concentration of 4g/bbl, 6g/bbl 8g/bbl of Cassava starch (100:0) as samples (3,4,5) replacing PAC giving rise to five mud samples (Fig.3).

2.2.3.3. Fluid Loss Test

The mud sample was poured into the API filter press assembly and using the Whatman 50 filter paper, the reservoir was filled up to the scribed mark. A previously graduated measuring cylinder was kept in place under the mud reservoir. Then, pressure of 100 Psi was applied to the reservoir at 25°C for 30 minutes. The filtrate in the cylinder was read and recorded as the fluid loss after 30minutes.

2.2.4. Calculation

2.2.4.1. Bulk density for starch

Mass of starch = 0.05kg, Volume of occupied = $0.000081m^3$
From Equation 1:

$$Density = \frac{0.05\ kg}{0.000081m^3} = 617.3kg/m^3$$

2.2.4.2. Moisture content for starch

M_i = Initial mass of starch sample (before drying) = 20.0g
M_f = Final mass of starch sample (after drying) = 19.178g
From Equation 2:

$$Percentage\ Moisture\ Content = \frac{20.0 - 19.178}{20}\ X\ 100$$

Percentage Moisture Content = 4.11%

3. RESULTS

3.1. Starch Yield

46.5 kg of TMS 98/0505 of cassava tubers employed yielded 4.00kg of starch.

3.2. Physiochemical Properties of Extracted Starch

The physiochemical properties of the starch obtained was analyzed and compared to that of PAC. The physiochemical properties of the starch analyzed are as detailed in Table 2.

Table 4 Fluid properties of Produced Mud Samples

Sample	1	2	3	4	5
Volume of Filtrate (ml)	9.2	4.2	8.0	7.2	6.0

3.3. Fluid Loss Test

The amount of filtrate collected for each sample at the same period of time is shown in Table 4.

4. DISCUSSION

4.1. pH

The pH accounts for the acidic or basic nature of substances. The level of hydrogen cyanide (HCN) content in cassava is the basis for its toxicity. The cassava starch sample was in the range of 7-8 indicating neutral or slightly alkaline on the pH meter. TMS 98/0505 had a pH value of 7. The HCN content in cassava is inversely proportional to the pH value, i.e the higher the content of HCN, the lower the pH value and vice versa. The starch sample had the same pH value as the PAC.

4.2. Bulk Density and Appearance

The values of bulk density of starch sample showed slight differences (Table 1); it was observed that starch from different varieties had large differences in bulk density depending on the specie source, (Moorthy 1999). However, starch sample is whitish similar to that of PAC.

4.3. Moisture Content

The moisture content of starch depends to a large extent on the method of drying and drying conditions (Shildreck and Smith, 1967). The moisture content for the starch sample analyzed was less than 5% which is close to that of PAC as <7%.

4.4. Particle Size Distribution and Dispersion

The size of starch granule is important in determining the suitability of starch for certain applications, this also could improve and increase the binding and reduce the breakage of final product (Aprianita, 2010). The results of particle size distribution for the starch sample (TMS 98/0505) are detailed in Table 3, while Figure 2 showed the graphical representation of the particle size distribution for the starch sample.

4.5. Fluid Loss Test

The amount of filtrate collected for each sample at the same period of time is shown in Table 4. For a drilling mud to be accepted, the fluid loss additive used should be able to give filtrate loss volume less than 15 ml over a period of 30 minutes (API 13 A, 1993). All the mud samples met these criteria. From the graph above it is seen that sample 2 which is 2g/bbl PAC had the least filtrate volume while the volume of filtrate was observed to be in reduction as the concentration of the cassava starch was increasing. This reduced fluid loss may be due to the similarities in the polyanionic cellulose and cassava starch molecules. The cassava starch molecules are attracted towards the polyanionic cellulose molecules and also induce the formation of micelles. The main attraction forces are hydrophobic and the presence of oppositely charged particles enhances interaction (Odeh, 2006). It was also observed that as more concentration of cassava starch was added to the formulation of Sample 1 the volume of the fluid loss was reduced implying that more concentration of cassava starch was required for a less concentration of PAC.

5. CONCLUSION

For a drilling mud to pass this crucial test it filtrate loss volume must be less than 15 ml over a period of 30 minutes (API 13 A, 1993). All the mud samples met the criteria. The result of the properties of the starch from the cassava specie measured shows that TMS 98/0505 has closer similarities in terms of pH value and bulk density to PAC. Consequently, starch obtained from improved cassava varieties and increased concentration in formulation can replace PAC as a fluid loss control agent in the formulation of the water based drilling fluid.

SUMMARY OF RESEARCH

1. This work, within the limit of available resource, has provided useful information as to other uses and application of cassava starch.
2. It has availed scientists the opportunity to research more on the usefulness of cassava and sourcing for other local materials.

FUTURE ISSUES

From the findings, TMS 98/0505 gave a high yield of starch, suggesting that more hybrid cassava species be researched and be employed for commercial production of cassava starch.

DISCLOSURE STATEMENT

There is no financial support for this research work from the funding agency.

ACKNOWLEDGMENT

Much thanks to our guide for his constructive criticism, and assistance towards the successful completion of this research work. Also to Hamilton Technologies Limited who gave me a laboratory for the success of this project.

REFERENCE

1. American Petroleum Institute (API) Recommended Practice for Field Testing Water Based Drilling Fluids, 13A,1993
2. Aprianita A. Assessment of underutilized starchy roots and tubers for their applications in the food industry, 2010, Graduate Thesis, Victoria University, Australia
3. Barlow MJ, Kingston PF. Observations on the Effects of Barite on the Gill Tissues of the Suspension Feeder Cerastoderma edule (linne) and the Deposit Feeder Macoma balthica (Linnne). *Marine Pollution Bulletin* 2001, 42, 71-76
4. Caenn R, Chillingar GV. Drilling fluids: State of the Art. *Journal of Petroleum Science and Engineering*, 1996, 14, 221-230
5. Carlos DM, George EH, Drilling Fluids Technology, Petro skills, LLC. OGCI Company. Tulsa, Oklahoma, 2004
6. Davies JM, Kingston JF. Sources of environmental disturbance associated with offshore oil and gas development In Cairns WJ (ed.) North Sea Oil and the environment- developing oil and gas resources, environmental impacts and responses. *International Council on Oil and the Environment*, Elsevier, London, 1992, P 417- 440
7. Donald LP, Truman PP, Robert Bk. The global Cassava development strategy and implementation plan, 2001,Vol.1, Transforming traditional tropical root crop proceedings of the validation forum on the global Cassava development strategy and implementation plan, FAO and IFAD, Rome
8. Engelhardt FR, Hall HA, Paterson R J, Strong DC. Oil Based Drilling Muds in the North Sea- A perspective. *Environmental Protection Branch*, 1983, 3
9. Hamilton Technology Limited, Laboratory Manual, 2001
10. Holdway DA. The Acute and Chronic Effects of Wastes Associated with Offshore Oil and Gas Production on Temperate and Tropical Marine Ecological Processes. *Marine pollution bulletin*, 2002, 44, 185-203
11. Moorthy SN. Effect of steam pressure treatment on the physicochemical properties of Dioscorea starches *J. Agric. Food Chem*. 1999, 47, 1695-1699
12. National Root Crops Research Institute (NRCRI), conference paper at Umudike, Nigeria, 2010
13. Odeh F. Polymer and Surfactant interaction, retrieved lecture note Dept. of Chemistry, Clarkson University, 2006
14. Shildreck P, Smith CE. Production and Uses of acid modified starch. In Starch: Chemistry and Technology, 1967, Vol. II Industrial Aspect
15. Terzaghi C, Buffagni M, Cantelli D, Bonfanti F and Camatini M. Physical-Chemical and Ecotoxicological Evaluation of Water Based Drilling Fluids Used in Italian Offshore. *Chemosphere* 1988, 37, 2859-2871